

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

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TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 154

AN INSTRUMENT FOR RECORDING THE POSITION
OF AIRPLANE CONTROL SURFACES.

By K. M. Ronan.

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In its program for an exhaustive analysis of the characteristics of airplanes in flight the N. A. C. A. has developed an instrument which makes a continuous record of the angular position of the control surfaces of an airplane, not only in steady flight but during acrobatics as well. It has proven useful in researches into stability and controllability, and from records obtained from it many otherwise obscure details of piloting technique have been available for the instruction of pilots, from novices to seasoned experts.

The present instrument supersedes the one described in Technical Note No. 97, having an improved internal mechanism, a wider range of adaptability, and a higher degree of accuracy. It has a standard base and motor drive as shown in Figs. 1 and 2. The constant speed motor A rotates the film clutch B at a constant speed which may be set from 1 to 10 R.P.M., as desired, through a worm gear in the base. The motion of the controls is transmitted to the recording mechanism by the cords C which lie in the helical grooves of the drums D, and are held taut by spiral springs within the drums. Gear teeth on the levers E engage in the helical grooves and steel wires F transmit their motion to arms hold-

ing a system of mirrors. The mirrors reflect the light beam from an incandescent lamp, housed in a tubular lighthouse, through a lens G which focuses the light beam on the film. A sector shutter H slowly revolving in front of the mirrors, produces full, dash and dotted lines on the record (Fig. 3). An adjustable reference mirror held by a set-screw I makes a base line on the record, from which the position of the other lines are determined.

There are three corresponding notches in the levers E and the arms controlling the mirrors, in which the wires F may be fixed. This forms a reducing mechanism, allowing a sensitivity range of from 6 to 14 inches movement of the control attachments for a full scale deflection of the light beam on the film. The cords can be attached to any portion of the control system; but, if a high degree of accuracy is desired, it is advisable to avoid backlash errors by attaching them to steel wires running directly to the control horns. If this is done, with the least sensitive setting a precision of $1/5^{\circ}$ is obtained, which is ample for ordinary work. The instrument is calibrated in place by setting the control surfaces at known angles and recording their position on the film.

Some records taken on the instrument are shown in Fig. 3. The elevators, ailerons and rudder are full, dash and dot lines, respectively. The record first shows the controls held in neutral on the ground. Second is a record of level flying in smooth air, the record bringing out the interesting characteristic that it is necessary to carry right rudder to counteract the torque. The/^{third} is

a loop, showing the stick pulled steadily back at the same time the rudder is operated in order to keep from sliding off. The next two are wing-overs, the first of which was smoothly flown through as shown by the evenness of the rudder movement, while in the second, the controls were handled roughly and the airplane came out of it skidding. The last, a landing, shows too large a range of movement of both rudder and elevator for a smooth glide, although the landing itself was good.

In tests of maneuverability, controllability and stability, the knowledge of the position of the controls is essential. In maneuverability investigations the speed of response of the airplane to the control movements, is desired. In controllability tests, the ease and quickness with which the controls can be moved, and the ability to hold or move an airplane into any position is studied. In research on stability, the condition which the airplane assumes with the controls locked in different positions, and the controls free, is determined. In other tests involving accelerated flight, it may be desired to execute a maneuver in one of several ways, as, for instance, flying through a fast wing-over or jerking the controls through a slow one. While the pilot has his relative idea of the execution, for precision it is best to ascertain the speed and range of control movement from a record which can be synchronized on the same time base with other records taken during flight.

This ^{instrument} can, however, be easily adapted to other than scientific work. It would be convenient as an aid in determining a pilot's

ability and showing him his weakness. With a little study of the records, it would be easy to pick out the pilots who slipped or skidded in banking, for they must counteract the effect with reverse control, or one who habitually "fights" the stick by the unevenness of his control movements. The pilot who, on landing, holds his airplane in an even glide, levels off steadily and holds this attitude until the airplane settles to the ground, will have a different record to show than the one who continually changes his glide angle, over-controls in leveling off, and lands in a "series of graceful bounds."

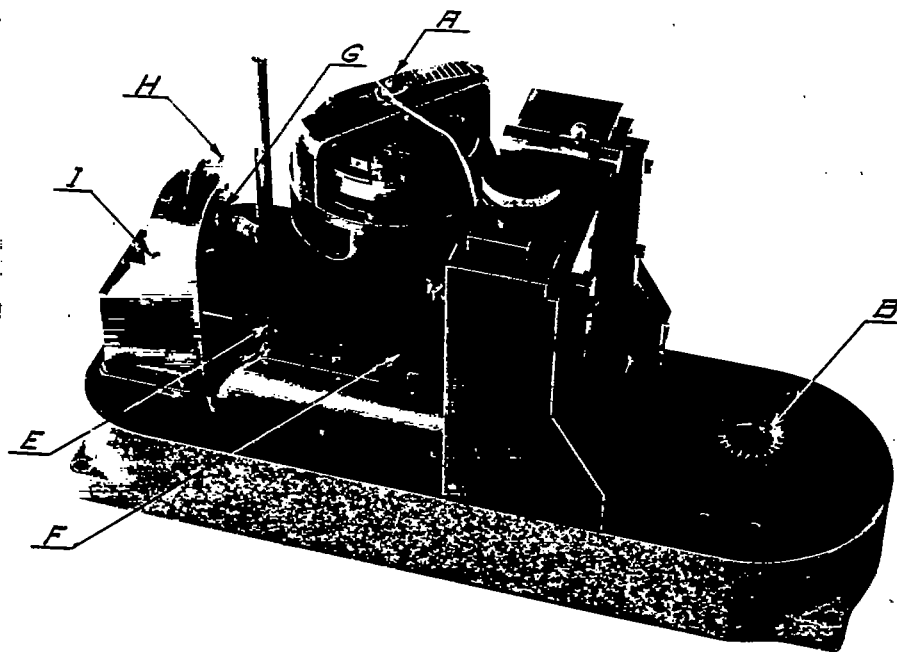


Fig. 1

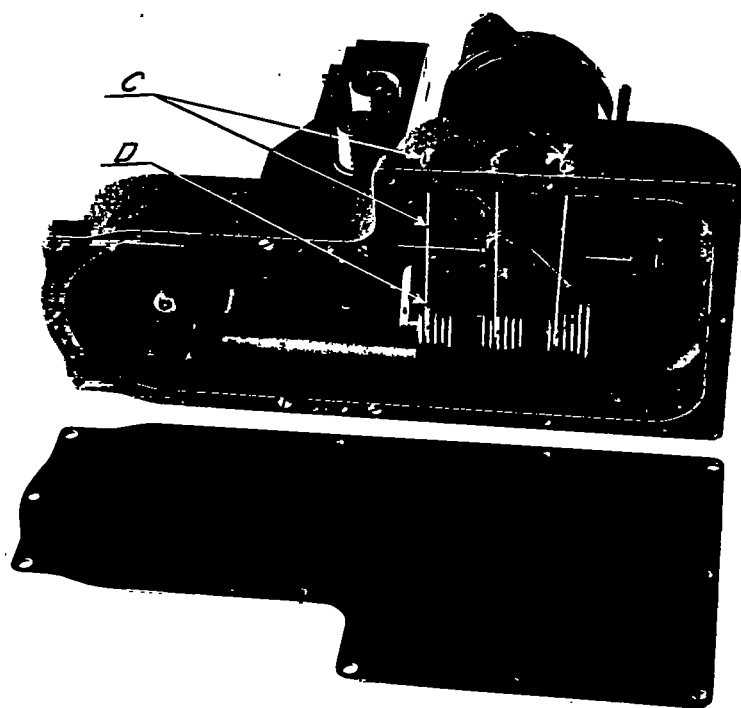


Fig. 2

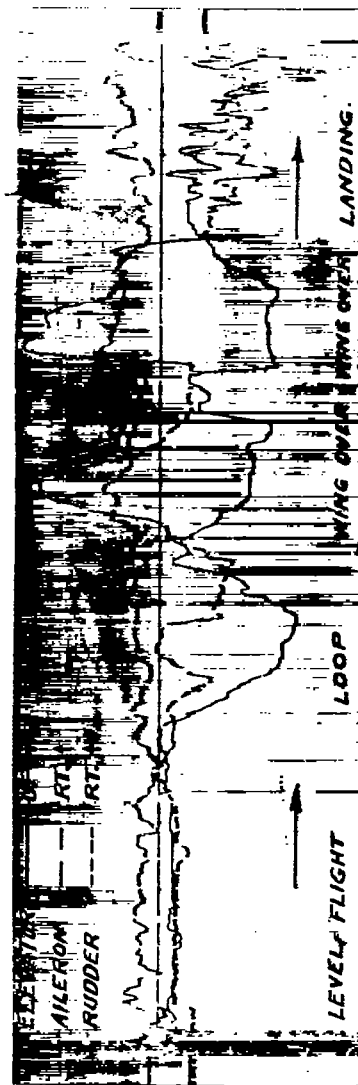


Fig. 3

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